Nuclear Operating Company

South Texas Project Nuclear Operating Company P.O. Box 289 Wadsworth, Texas 77483

November 30, 2005
NOC-AE-05001943
10CFR50.73

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852

South Texas Project
Unit 2
Docket No. STN 50-499
Licensee Event Report 2-2005-04, Supplement 1
Inoperability of Essential Cooling Water 2A and 2B Trains

Reference: Letter, G. L. Parkey to Document Control Desk, "Licensee Event Report 2-2005-04, Inoperabliity of Essential Cooling Water 2A and 2B Trains," September 12, 2005 (NOC-AE-05001929, ML052630031)

Pursuant to 10 CFR 50.73(a)(2)(i)(B) and 10 CFR 50.73(a)(2)(vii), STP Nuclear Operating Company submits the attached supplement to Licensee Event Report 2-2005-04 regarding the inoperability of Essential Cooling Water trains 2A and 2B. Additional or changed information is annotated by a change bar in the right margin of the Report.

This event did not have an adverse effect on the health and safety of the public.

There are no commitments contained in this event report. Resulting corrective actions will be implemented in accordance with the Corrective Action Program.

If there are any questions regarding this submittal, please contact S. M. Head at (361) 972-7136 or me at (361) 972-7800.

G. L. Parkey
Vice President, Generation
and Plant General Manager

jal/

Attachment: LER 2-2005-04, Supplement 1

IE22

STI: 31944370

cc:
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NRC FORM 366 (6-2004) U.S. NUCLEAR REGULATORY COMMISSION

APPROVED BY OMB: NO. 3150-0104 EXPIRES: 06/30/2007

Estimated burden per response to comply with this mandatory collection request: 50 hours. Reported lessons learned are incorporated into the licensing process and fed back to industry. Send comments regarding burden estimate to the Records and FOIA/Privacy Service Branch (T-5 F52), U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001, or by internet e-mail to infocollects@nrc.gov, and to the Desk Officer, Office of Information and Regulatory Affairs, NEOB-10202, (3150-0104), Office of Management and Budget, Washington, DC 20503. If a means used to impose an information collection does not display a currently valid OMB control number, the NRC may not conduct or sponsor, and a person is not required to respond to, the information collection.

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

1. FACILITY NAME	2. DOCKET NUMBER	3. PAGE
South Texas Unit 2	05000 499	1 OF 11

4. TITLE

Essential Cooling Water Inoperable Longer Than Allowed Outage Time

5. EVENT DATE			6. LER NUMBER			7. REPORT DATE			8. OTHER FACILITIES INVOLVED	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REV NO.	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
										05000
7	11	2005	2005	- 004 -	1	11	30	2005	FACILITY NAME	DOCKET NUMBER 05000

9. OPERATING MODE

1

10. POWER LEVEL

100

11. THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR§: *(Check all that apply)*

☐ 20.2201(b)	☐ 20.2203(a)(3)(i)	☐ 50.73(a)(2)(i)(C)	☒ 50.73(a)(2)(vii)
☐ 20.2201(d)	☐ 20.2203(a)(3)(ii)	☐ 50.73(a)(2)(ii)(A)	☐ 50.73(a)(2)(viii)(A)
☐ 20.2203(a)(1)	☐ 20.2203(a)(4)	☐ 50.73(a)(2)(ii)(B)	☐ 50.73(a)(2)(viii)(B)
☐ 20.2203(a)(2)(i)	☐ 50.36(c)(1)(i)(A)	☐ 50.73(a)(2)(iii)	☐ 50.73(a)(2)(ix)(A)
☐ 20.2203(a)(2)(ii)	☐ 50.36(c)(1)(ii)(A)	☐ 50.73(a)(2)(iv)(A)	☐ 50.73(a)(2)(x)
☐ 20.2203(a)(2)(iii)	☐ 50.36(c)(2)	☐ 50.73(a)(2)(v)(A)	☐ 73.71(a)(4)
☐ 20.2203(a)(2)(iv)	☐ 50.46(a)(3)(ii)	☐ 50.73(a)(2)(v)(B)	☐ 73.71(a)(5)
☐ 20.2203(a)(2)(v)	☐ 50.73(a)(2)(i)(A)	☐ 50.73(a)(2)(v)(C)	☐ OTHER
☐ 20.2203(a)(2)(vi)	☒ 50.73(a)(2)(i)(B)	☐ 50.73(a)(2)(v)(D)	Specify in Abstract below or in NRC Form 366A

12. LICENSEE CONTACT FOR THIS LER

FACILITY NAME	TELEPHONE NUMBER (Include Area Code)
Robyn Savage	(361) 972-7438

13. COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT

CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX	CAUSE	SYSTEM	COMPONENT	MANU-FACTURER	REPORTABLE TO EPIX
X	BI	PSP	S280	Yes					

14. SUPPLEMENTAL REPORT EXPECTED

☐ YES *(If yes, complete 15. EXPECTED SUBMISSION DATE)* ☒ NO

15. EXPECTED SUBMISSION DATE

MONTH	DAY	YEAR

ABSTRACT *(Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines)*

In May 2005, cavitation damage was discovered in the slip-on flange assembly immediately downstream of the Component Cooling Water (CCW) Heat Exchanger 1B Essential Cooling Water (ECW) Return Throttle Valve, 1-EW-0064. Work requests were initiated to inspect the CCW heat exchanger return throttle valves in all trains of both units. Cavitation pitting, circumferential pipe cracking, secondary axial pipe cracking, and pipe end to flange weld separation were discovered in the aluminum bronze pipe inside a slip-on flange immediately downstream of the CCW Heat Exchanger 2A ECW Return Throttle Valve, 2-EW-0027. Structural integrity of the pipe could not be verified using the requirements of NRC Generic Letter 90-05, "Guidance for Performing Temporary Repair of ASME Code Class 1, 2, and 3 Piping." Because structural integrity could not be demonstrated, ECW Train 2A was declared non-compliant with ASME Code requirements and INOPERABLE per Technical Specification requirements.

STP Nuclear Operating Company (STPNOC) has determined, based on metallurgical analysis of the failed parts, that ECW Train 2A was inoperable for an undetermined period of time. The condition logically existed for a period longer than the Technical Specification 3.7.4 Allowed Outage Time although the length of time is not known. As a result STPNOC considers this event reportable pursuant to 10CFR50.73(a)(2)(i)(B) as a Condition Prohibited by Technical Specifications. In addition, on August 15, 2005 an inspection of the corresponding Train 2B throttle valve, 2-EW-0064, discovered a similar condition. Therefore, this event is also reportable pursuant to 10CFR50.73(a)(2)(vii) as a Common-cause Inoperability of Independent Trains.

The root cause is the failure to incorporate requisite inspection activities for ECW piping into station programs. ECW 2A and 2B conditions have been repaired using ASME code requirements.

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		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	
South Texas Unit 2	05000 499	2005	004	1	2 OF 11

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

I. DESCRIPTION OF REPORTABLE EVENT

A. REPORTABLE EVENT CLASSIFICATION

This event is reportable pursuant to 10CFR50.73(a)(2)(i)(B) as a Condition Prohibited by Technical Specifications and 10CFR50.73(a)(2)(vii) as a Common Cause Inoperability of Independent Trains. STPNOC has determined, based on metallurgical analysis of the failed parts, that Essential Cooling Water (ECW) Train 2A was inoperable for an undetermined period of time. Since this condition developed slowly it logically existed for a period longer than the Technical Specification 3.7.4 Allowed Outage Time although the length of time can not be determined definitively. Even though there is no evidence of the time of inoperability STPNOC submits this report pursuant to 10CFR50.73(a)(2)(i)(B) as a Condition Prohibited by Technical Specifications. Inspections on ECW Train 2B on 15 August 2005 discovered a similar condition and inoperability. Since the two independent ECW Trains 2A and 2B were reasonably inoperable during the same period for the same cause this condition is also reportable per 10CFR50.73(a)(2)(vii) as a Common-cause Inoperability of Independent Trains.

B. PLANT OPERATING CONDITIONS PRIOR TO THE EVENT

Unit 2 operated in Mode 1 at full power for the duration of this event.

C. STATUS OF STRUCTURES, SYSTEMS, OR COMPONENTS THAT WERE INOPERABLE AT THE START OF THE EVENT AND THAT CONTRIBUTED TO THE EVENT

When the first indications of the condition were noticed for ECW Train 2A due to through-wall leakage on 27 June 2005, ECW Train 2C was out of service, but functional, for routine scheduled traveling screen maintenance.

D. NARRATIVE SUMMARY OF THE EVENT, INCLUDING DATES AND APPROXIMATE TIMES

In May 2005, cavitation damage was discovered in the slip-on flange immediately downstream of the Unit 1 Component Cooling Water (CCW) Heat Exchanger 1B ECW Return Throttle Valve, 1-EW-0064. Work requests were then initiated to inspect the component cooling water heat exchanger return throttle valves in all trains of both units.

1. FACILITY NAME	2. DOCKET	6. LER NUMBER			3. PAGE
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South Texas Unit 2	05000 499	2005	004	1	3 OF 11

NARRATIVE *(If more space is required, use additional copies of NRC Form 366A)* (17)

On June 27, 2005, approximately three gallons per hour leakage was discovered from the flange downstream of 2-EW-0027. The leakage was from two discrete pinpoint flaws located in the carbon steel flange hub near the joint fillet weld of the pipe to the carbon steel flange hub. A subsequent operability evaluation performed on 29 June 2005 concluded that the ECW Train 2A was operable with the through wall leakage (CREE 05-8601-1). Compensatory actions were taken to monitor the leakage and limits were set for circumferential crack length at the outside surface of the flange. The 2-EW-0027 inspection and repair was rescheduled to the next available 2A train work week.

When the train 2A 2-EW-0027 throttle valve was removed on July 11, 2005, cracks were discovered in the aluminum bronze piping inside the downstream slip-on flange:

- The aluminum bronze pipe end had separated for about 34.5 inches along the heat affected zone of the pipe end to flange fillet seal weld. This separation was located where the disc of 2-EW-0027 entered the downstream flange. The total circumferential length of this fillet seal weld is about 93".

- The aluminum bronze pipe had a 17.6 inch long circumferential crack along the upper side of the heat affected zone of the external (lower) pipe to flange hub fillet weld. This crack was also located where the disc of 2-EW-0027 entered the downstream flange.

- There was a 3.5 inch long axial crack through the aluminum bronze pipe, connecting the 34.5 inch long pipe separation and the 17.6 inch long circumferential crack.

- Just past the end of the 34.5 inch separation, there was another 1.5 inch long separation of the aluminum bronze pipe end along the heat affected zone of the pipe end to flange fillet seal weld.

- There were three additional pipe end separations on the side of the pipe opposite the location of the 34.5 inch separation. These separations were 3.5, 2.5, and 1.8 inches long.

- Two through-wall cavitation impingement areas were located in the aluminum bronze pipe just below the pipe end to flange fillet seal weld. The through-wall areas were located where each side of the disc of 2-EW-0027 just entered the downstream flange.

- At the two through-wall cavitation impingement areas, pitting of the carbon steel slip-on flange extended to about one inch deep. Ultrasonic thickness readings taken from the outside of the flange at the hub below the bolting ring showed minimum remaining thickness of about 0.61 inches from an initial nominal thickness of 1.28 inches. Metal loss at this lower point was over about a two inch wide area.

- Dye-penetrant testing revealed five pinhole indications all within about a two inch area in the carbon steel flange hub at the heat affected zone of the external (lower) pipe to flange hub fillet weld. Two of these pinhole indications had active water leakage.

Inspection of the 2-EW-0027 valve and upstream flange revealed erosion wear of the aluminum bronze pipe where the valve disc entered the upstream flange and cavitation impingement damage to the valve body and travel stop. A segment of the valve's Tefzel seat ring was missing. The eroded areas maintained adequate thickness so that the structural integrity of the valve body was not challenged.

A second operability and reportability review was then performed to assess the aluminum bronze pipe damage discovered in the downstream flange (CREE 05-8601-16). The 17.6 inch long circumferential crack along the upper side of the heat affected zone of the external (lower) pipe to flange hub fillet weld exceeded NRC Generic Letter 90-05's allowed crack size limit of three inches. Flaw evaluations were performed for the aluminum bronze pipe using linear elastic fracture mechanics methodology and limit load methodology to determine maximum critical crack size and bending loads allowed prior to catastrophic pipe failure. The structural integrity of the pipe was never compromised as the calculated safety margins exceeded one. However, since the calculated safety margins were less than the ASME required margins, ECW Train 2A was declared inoperable.

After the downstream flange for Train 2A was replaced via an ASME code repair, the downstream flange for Train 2C was inspected and replaced via an ASME code repair. The Train 2C flange had separation of the aluminum bronze pipe from the heat affected zone of the pipe end to flange fillet seal weld but no circumferential or axial cracking in the aluminum bronze pipe. This slip-on flange did have two through-wall locations where corrosion of the carbon steel flange undermined the aluminum bronze overlay at the gasket seating area, but no through wall leakage. The observed damage for ECW Train 2C was within previous structural integrity acceptance criteria for flaw evaluations and the condition was evaluated as meeting operability requirements.

On 15 August, the downstream flange for Train 2B was inspected. This flange had an approximately 30" long by three inches wide segment of the aluminum bronze pipe broken free. A segment of broken pipe recovered during the inspection (about twenty inches long by three inches wide) was lodged between the pipe outside diameter and slip-on flange inside diameter. The remainder of the segment (up to ten inches long by three inches wide) is unrecovered and may have traveled some distance in the return header towards the discharge structure. CR 05-10323 evaluates the system impact of the unrecovered aluminum bronze pipe segment(s). ECW Train 2B was also declared inoperable for the same reasons as ECW Train 2A.

See Table 1 for a summary of the inspections results, operability determinations and repairs for ECW trains.

E. THE METHOD OF DISCOVERY OF EACH COMPONENT OR SYSTEM FAILURE, OR PROCEDURAL OR PERSONNEL ERROR

The conditions in ECW Trains 2A and 2B were discovered after inspections were performed in Unit 1. The initial inspection in Unit 1 discovered cavitation induced erosion in the CCW Heat Exchanger outlet throttle valve configuration. As a result of this initial discovery STPNOC determined that inspection of all trains in both Units was appropriate. Of the six trains inspected, the conditions discovered in ECW Trains 2A and 2B did not meet operability requirements.

II. COMPONENT OR SYSTEM FAILURES

A. FAILURE MODE, MECHANISM, AND EFFECTS OF EACH FAILED COMPONENT

Cavitation pitting, circumferential cracking, secondary axial cracking and pipe end to flange weld separations were discovered in the aluminum bronze pipe inside a slip-on flange immediately downstream of the Component Cooling Water Heat Exchanger 2A and 2B Essential Cooling Water (ECW) Return Throttle Valves. Structural integrity of the pipe could not be verified using the requirements of NRC Generic Letter 90-05, "Guidance for Performing Temporary Repair of ASME Code Class 1, 2, and 3 Piping." Because structural integrity could not be demonstrated, ECW Trains 2A and 2B were declared inoperable due to non-compliance with ASME Code requirements.

B. CAUSE OF EACH COMPONENT OR SYSTEM FAILURE

The cause of the damage observed in the pipe/flange assembly is cavitation impingement from the heavily throttled butterfly valve.

C. SYSTEMS OR SECONDARY FUNCTIONS THAT WERE AFFECTED BY FAILURE OF COMPONENTS WITH MULTIPLE FUNCTIONS

None

D. FAILED COMPONENT INFORMATION

The aluminum-bronze pipe has a nominal diameter of 30 inches and a nominal thickness of 0.25 inch. The pipe material is SB 169 CA-614 rolled and welded plate (6-8 percent aluminum) fabricated to SA-155 dimensional tolerances. The slip-on flange material is SA-105 carbon steel. The slip-on flange is welded to the 30-inch aluminum bronze pipe with fillet welds at both ends.

III. ANALYSIS OF THE EVENT

A. SAFETY SYSTEM RESPONSES THAT OCCURRED

Not Applicable. Condition discovered during planned maintenance.

B. DURATION OF SAFETY SYSTEM TRAIN INOPERABILITY

STPNOC has determined, based on metallurgical analysis of the failed parts that ECW Train 2A was inoperable for an undetermined period of time that logically existed for a period longer than the Technical Specification 3.7.4 Allowed Outage Time. The length of time can not be determined definitively since the slow development of the condition provided no evidence of the time of inoperability. Inspections on ECW Train 2B on 15 August 2005 discovered a similar condition and inoperability. The length of inoperability can not be determined definitively for ECW 2B either since the slow development of the condition provided no evidence of the time of inoperability.

C. SAFETY CONSEQUENCES AND IMPLICATIONS

Engineering analysis (APTECH calculation AES-C-5862-1, CR 05-8601-25) determined that the discovered condition on ECW Train 2A justified the acceptance criteria for both the upset and faulted conditions per the 2004 edition of the ASME Section XI pipe flaw acceptance criteria. STPNOC is committed to the 1989 version of the ASME code and used those limits to determine operability impact. Since ECW Train 2A was acceptable per the 2004 version of the code and since ECW Train 2C was considered operable, the safety function for the ECW system was met and the safety consequences were low.

A subsequent engineering analysis of the as-found condition of the aluminum bronze pipe carbon steel slip-on flange configuration of the ECW train 2A and ECW 2B flanges was performed (CR 05-8601-33). This analysis determined that the ECW pipe to flange assembly was capable of maintaining structural integrity during seismic events.

Replacement of the flanges resulted in 108 hours of ECW Train 2A unavailability and 88 hours of ECW Train 2B unavailability. The increase in core damage risk accrued by this unavailability time was controlled within the limits of the Configuration Risk Management Program.

Probabilistic risk assessment sensitivity studies were performed assuming guaranteed flange failure due to a seismic event (CR Action 05-8601-31). Assuming a single ECW train will fail during a seismic event and that all components serviced by that ECW train will fail, the Change in Core Damage Frequency was 1.8E-08 per year and the Change in Large Early Release Frequency was 1.5E-09 per year. In a bounding analysis, assuming all ECW trains and all systems associated with ECW will fail during a seismic event, the Change in Core Damage Frequency was 1.3E-06 per year and the Change in Large Early Release Frequency was 1.3E-07 per year.

IV. CAUSE OF THE EVENT

The root cause is the failure to incorporate requisite inspection activities for ECW piping into station programs.

V. CORRECTIVE ACTIONS

1. Rework affected piping and components in accordance with applicable codes and Piping Specification 5L019PS0004.

Train 1A EW0027	CR 05-7071-20	Due date: 1RE13
Train 1C EW0101	CR 05-7071-19	Due date: 1RE13
Train 1B EW0064	CR 05-7071-18	Due date: 1RE13
Train 2A EW0027	CR 05-8601-3	Completed
Train 2B EW0064	CR 05-7071-12	Completed
Train 2C EW 0101	CR 05-7071-13	Completed

2. Provide design change package to allow Belzona or equivalent product that is resistant to cavitation damage to be coated on affected internal piping and component surfaces at the subject valves.
   DCP CR 05-8601-18 Completed

3. Develop Preventive Maintenance activities to inspect internal piping downstream of CCW heat exchanger outlet butterfly valves to monitor effectiveness of the Belzona product application in the reduction of any cavitation damage.

Unit 1	CR 05-8601-36	Completed
Unit 2	CR 05-7601-37	Completed

4. Implement an erosion monitoring program for the ECW system or incorporate requisite inspection activities into existing programs.

   CR 05-8601-35 Due Date: 1/17/06

SUPPORTING ACTIONS

1. Perform an engineering analysis of the actual aluminum bronze pipe carbon steel slip-on flange configuration with the as-found conditions of the ECW Train 2A and ECW Train 2B flanges.
   CR 05-8601-33 Completed

2. Contract with a hydraulics/piping consultant to perform a review of the system conditions of the Component Cooling Water Heat Exchanger ECW Return Throttle Valves and determine additional strategies to reduce or eliminate cavitation.
   CR 05-8601-34 Due Date: 3/15/06

VI. PREVIOUS SIMILAR EVENTS

None.

Table 1 – ECW Inspection Summary

Train	Date Inspected	Type of Indications Found	Operability	Type of Repair
1B	05/16/05	1. Through-wall penetration of the aluminum bronze pipe in two areas just below the pipe end to flange fillet seal weld. 2. Pitting into the carbon steel flange hub at these through-wall penetration areas extended as deep as 0.75 inches.	Operable	*Non-Code Repair: The aluminum bronze piping was coated with Belzona material until a permanent Code repair can be performed.
1C	05/23/05	1. Through-wall penetration of the aluminum bronze pipe in two areas just below the pipe end to flange fillet seal weld. 2. Pitting into the carbon steel flange hub at these through-wall penetration areas extended as deep as 0.78 inches. 3. The aluminum bronze pipe end had separated for about 20 inches along the heat affected zone of the pipe end to flange fillet seal weld. 4. The aluminum bronze pipe had a 6 ½ inch long circumferential crack along the upper side of the heat affected zone of the external (lower) pipe to flange hub fillet weld.	Operable	*Non-Code Repair: A weld overlay was performed over the crack and a non-Code seal weld was performed over the separation area. The two through-wall pipe penetration areas were cut out and sections of aluminum bronze pipe were used as filler and welded in place. The aluminum bronze piping was coated with Belzona material until a permanent Code repair can be performed.
1A	07/05/05	1. Through-wall penetration of the aluminum bronze pipe in two areas just below the pipe end to flange fillet seal weld. 2. Pitting into the carbon steel flange hub at these through-wall penetration areas extended as deep as 1.15 inches. 3. The aluminum bronze pipe end had separated for about 11 ¼ inches along the heat affected zone of the pipe end to flange fillet seal weld.	Operable	*Non-Code Repair: A seal weld was performed over the separation area and the aluminum bronze piping was coated with Belzona material until a permanent Code repair can be performed.

**Relief requests have been submitted for the non-code repairs on ECW Trains 1A, 1B and 1C.*

Table 1 – ECW Inspection Summary (Continued)

Train	Date Inspected	Type of Indications Found	Operability	Type of Repair
2A	07/11/05	See Section I.D above.	Inoperable	ASME Code Repair: The slip-on flange assembly was replaced with a new slip-on flange assembly and the pipe internals were coated with a cavitation resistant Belzona compound.
2C	07/25/05	1. Through-wall penetration of the aluminum bronze pipe in two areas just below the pipe end to flange fillet seal weld. 2. Two through-wall locations where corrosion of the carbon steel flange undermined the aluminum bronze overlay at the gasket seating area with no through wall leakage. 3. The flange had separation of the aluminum bronze pipe from the heat affected zone of the pipe end to flange fillet seal weld but no circumferential or axial cracking in the aluminum bronze pipe.	Operable	ASME Code Repair: The slip-on flange assembly was replaced with a new slip-on flange assembly and the pipe internals were coated with a cavitation resistant Belzona compound.
2B	08/15/05	1. This flange had an approximately 30" long by 3" wide segment of the aluminum bronze pipe broken free. 2. A broken pipe section recovered during the inspection (approximately 20" long by 3" wide) was lodged between the pipe outside diameter and slip-on flange inside diameter.	Inoperable	ASME Code Repair: The slip-on flange assembly was replaced with a new slip-on flange assembly and the pipe internals were coated with a cavitation resistant Belzona compound.